tion depend for their production upon more extensive modifications in the same directions.

I can only allude now very briefly to the effects of the third set of factors, the sizes of the sense organs, on the conformation of the skull. We have already noted that the shape and the size of the orbital opening depend on the jaw as much as on the eye. A careful set of measurements has convinced me that the relative or absolute capacity of the orbital cavity is of very little significance as a characteristic of race. The microseme Australian orbit and the megaseme Kanaka are practically of the same capacity, and the eyeballs of the two Australians that I have had the opportunity of examining are a little larger than those of the average of mesoseme Englishmen.

The nasal fossæ are more variable in size than the orbits, but the superficial area of their lining and their capacity are harder to measure, and bear no constant proportion to the size of their apertures, because it is impossible without destroying the skull to shut off the large air sinuses from the nasal fossæ proper for purposes of measurement. Thus the most leptorhine of races, the Esquimaux, with an average nasal index of 437 has a nasal capacity of 55 c.c.m., equal to that of the platyrhine Australian, whose average is 54·5, and both exceed the capacity of the leptorhine English, which average about 50 c.c.m. There is an intimate and easily proved connection between dental size and the extent of the nasal floor and of the pyriform aperture.

These are but a few of the points which a scientific craniometry should take into consideration. There are many others to which I cannot now refer, but which will naturally occur to the thoughtful anatomist.

In this rapid review of the physical side of our subject the study of these race-characters naturally suggests the vexed question as to the hereditary transmission of acquired peculiarities. This is too large a controversy for us now to engage in, but in the special instances before us there are grounds for the presmption that these characters of microdontism and megacephaly have been acquired at some stage in the ancestral history of humanity, and that they are respectively correlated, with diminution of use in the one case, and increase of activity in the other. It is a matter of observation that these qualities have become hereditary, and the point at issue is not the fact, but the mechanism, of the transmission. We know that use or disuse affects the development of structure in the individual, and it is hard to believe that the persistent disuse of a part through successive generations does not exercise a cumulative influence on its ultimate condition.

There is a statement in reference to one of these characters which has gained an entrance into the text-books, to the effect that the human alveolar arch is shortening, and that the last molar tooth is being crowded out of existence. I have examined 400 crania of men of the long, and round-barrow races, Romano-British and early Saxon, and have not found among all these a single instance of absence of the third molar or of overcrowded teeth. On the other hand, out of 200 ancient Egyptian skulls, 9 per cent. showed displacement or disease, and 1½ per cent. show the want of one molar tooth. Out of 200 modern English skulls there was no third molar tooth in 1 per cent. So far this seems to confirm the current opinion.

Yet the whole history of the organism bears testimony to the marvellous persistence of parts in spite of contumely and disuse. Take, for example, the present position of the little toe in man. We know not the condition of this digit in prehistoric man, and have but little information as to its state among savage tribes at the present day, but we do know that in civilised peoples, whose feet are from infancy subjected to conditions of restraint, it is an imperfect organ—

> Of every function shorn
> Except to act as basis for a corn.

In 1 per cent. of adults the second and third joints have ankylosed, in 3 per cent. the joint between them is rudimentary, with scarcely a trace of a cavity, in 20 per cent. of feet the organ has lost one or more of its normal complement of muscles. But though shorn of some of its elements, and with others as mere shreds, the toe persists, and he would be a bold prophet who would venture to forecast how many generations of booted ancestry would suffice to eliminate it from the organization of the normal man.

Nevertheless, although it is difficult to demonstrate, in the present imperfect state of knowledge, the method whereby race-characters have originated, I think that the most of our anthropologists at least covertly adopt the philosophy of the ancient proverb, "The fathers have eaten sour grapes and the children's teeth are set on edge."

But there are other branches of anthropology of far greater interest than these simple problems upon which we have tarried so long. The study of man's intellectual nature is equally a part of our subject, and the outcomes of that nature are to be traced in the tripartite record of human progress which we call the history of culture. It is ours to trace the progress of man's inventions, and their fruits in language and the arts, the direct products of the human mind. It is also ours to follow the history of man's discovery of those secrets of nature to the unfolding of which we give the name of science. The task is also ours to inquire into that largest and most important of all sections of the history of culture which deals with the relation of human life to the unseen world, and to disentangle out of the complex network of religion, mythology, and ritual those elements which are real truths, either discovered by the exercise of man's reason, or learned by him in ways whereof science takes no account, from those adventitious and invented products of human fear and fancy which obscure the view of the central realities. In this country it matters less that our time forbids us to wander in these fascinating fields wherein the anthropologist loves to linger, as the munificent benefaction of Lord Gifford has ensured that there shall he an annual fourfold presentation of the subject before the students of our Scottish universities. There is no fear that interest in these questions will flag for want of diversity in the method of treatment or of varieties in the standpoints of the successive Gifford lecturers.

From the ground of our present knowledge we can but faintly forecast the future of Anthropology, when its range is extended by further research, and when it is purged of fancies, false analogies, and imperfect observations. It may be that there is in store for us a clearer view of the past history of man, of the place and time of his first appearance, of his primitive character, and of his progress. But has this knowledge, interesting as it may be for its own sake, any bearing on the future of mankind? Hitherto growth in knowledge has not been accompanied with a commensurate increase in the sum of human happiness, but this is probably due to the imperfection which characterises even our most advanced attainments. For example, while the medical and sanitary sciences, by their progress, are diminishing the dangers which beset humanity, they have also been the means of preserving and permitting the perpetuation of the weaklings of the race, which, had natural selection exercised its unhindered sway, would have been crushed out of existence in the struggle for life.

It is, however, of the essence of true scientific knowledge, when perfected, that it enables us to predict, and if we ever rise to the possession of a true appreciation of the influences which have affected mankind in the past, we should endeavour to learn how to direct these influences in the future that they shall work for the progress of the race. With such a knowledge we shall be able to advance in that practical branch of Anthropology, the science of education; and so to guide and foster the physical, intellectual, and moral growth of the individual that he will be enabled to exercise all his powers in the best possible directions. And lastly, we shall make progress in that kindred department, Sociology, the study of which does for the community what the science of education does for the individual. Is it a dream that the future has in store for us such an Anthropological Utopia?

PHYSICS AT THE BRITISH ASSOCIATION.

THE mathematicians and physicists of the British Association could not have had better accommodation than that which was placed at their disposal in Edinburgh. The physics lecture-room of a University, with its appropriate fittings and appliances, is their ideal environment. Almost all the leading British physicists were present, the chief absentee of note being Lord Rayleigh, and foreign men of science were well represented by such men as Profs. von Helmholz, Wiedemann, Ostwald, and Du Bois, from Germany; M. Guillaume, from France; Schoute, from Holland; and Michelson, from America.

The *Discussion on a National Physical Laboratory* was one of the most important.

The speakers were Oliver Lodge, Glazebrook, von Helmholz, Lord Kelvin, Rücker, Dr. John Ince, Fitzgerald, Stokes, Carey Foster, Ayrton, and the President.

Prof. Lodge opened the discussion by giving an outline of the work which might be done in such a laboratory. The work should include the accurate determination of physical constants, the maintenance of standards, and the issue or verification of certified copies, the continuous recording of certain special phenomena, the conduction of certain special experimental inquiries, more particularly such as might have to be carried on years or even centuries; the taking up and completing of lines of research already developed by amateurs (or even in well-equipped laboratories) to that point at which it was impossible for them, unaided, to proceed farther.

Mr. Glazebrook described the work done at the Cavendish Laboratory. A part of this work consists in the testing of units of electrical resistance and electromotive force. In many cases it is quite impossible (in view of the more proper work of the laboratory) to give the necessary time for the proper carrying out of this work—which should be undertaken by a National Laboratory.

Prof. von Helmholz stated that one of the chief causes for the setting up of the National Physical Laboratory at Berlin was the desire of the Government that mechanicians should be assisted in their work by means of properly conducted scientific research and superintendence. It was necessary also that proper headquarters should exist for the construction and control of standards. The directors are entirely free from any duties of teaching, no systematic instruction being given in the laboratory. A large part of the work done consists in standardizing of thermometers. In the first year of the institution 90,000 were tested. Electrical apparatus, steam engine indicators, and standard lights for gas and electric companies, are also tested; and a considerable amount of thermodynamical work is undertaken with a view to practical improvements. £2500 are spent annually upon apparatus and work alone, exclusive of salaries.

Lord Kelvin said that it was a matter of great importance to the nation that its artizans should have as good scientific direction for their work as the artizans of Germany have for theirs.

Prof. Rücker said that it was by no means gratifying that it was necessary to send thermometers to Paris in order that they should be compared with the air thermometer. It would be of great advantage to have a national institution worked largely in connection with the Royal Society.

Prof. Fitzgerald, among other things, said that he doubted if the House of Commons was sufficiently educated to understand that the advance of scientific work was of national value.

The Discussion on Nomenclature of Units was opened by Prof. Oliver Lodge on lines recently indicated in Nature.

Dr. Hopkinson and Dr. Preece criticized the proposed changes, maintaining that the time had not yet arrived when they could be advantageously introduced, even if they were satisfactory, which was very questionable except in one or two cases.

Dr. du Bois also spoke in opposition to the proposed changes, remarking that, even if accepted in Britain, they certainly would not be favoured in Germany. The discussion then dropped.

The Report on Underground Temperature dealt with observations made in a boring at Wheeling, West Virginia. The well had been sunk by a company to a depth of 4500 feet. The company decided to abandon it at this stage; but on request the boring was continued to a much greater depth for the purpose of the scientific observations. During last summer observations of temperature were made at successive depths of 125 feet down to the bottom. The surface temperature being 51°, at a little more than 1000 feet below the surface, 68°·75 were registered. At 3000 feet and 4000 feet respectively, 87° and 102° were observed; and at the bottom of the well the temperature was 110°·15. The rate of increase grows with the depth. Between 1590 feet and 1835 feet, the average rate was 1° per 92 feet; between 1835 feet and 2486 feet it was 1° per 84·5 feet. This increased until at the foot the rate was 1° per 58 feet. The average rate was 1° per 72 feet.

Report on the Discharge of Electricity from Points.—As the result of the experiments made it was found that disturbing influences, which had little or no effect at the cathode, had a powerful effect when applied to the anode, so as even to prevent the passage of sparks. Experiments were also made with the view of determining the quantity of gas concerned in the passage of a given quantity of electricity.

Report on Electrical Standards.—The committee which submitted this report had a meeting at Edinburgh, which was attended by a number of foreigners. As a result of this meeting they agreed to the following resolutions:—(1) That the resistance of a specified column of mercury be adopted as the practical unit of resistance; (2) That 14·4521 grammes of mercury in the form of a column of uniform cross-section, 106·3 cm. in height, at 0° C., be the specified column; (3) That standards in mercury, or solid metal having the same resistance as this column, be made and deposited as standards of resistance for industrial purposes; (4) That such standards be periodically compared with each other, and also that their values be redetermined at intervals in terms of that of a freshly set up mercury column. It was further agreed that these resolutions be communicated to the Electrical Standards Committee of the Board of Trade. It was agreed that the number 0·001118 should be adopted as the number of grammes of silver deposited per second from a neutral solution of nitrate of silver by a current of one ampere, and that the electromotive force of a Clark cell at 15°C. should be taken as 1·434 volts.

Prof. von Helmholz remarked that a column of mercury was much preferable to alloys, in which small fissures might exist or come into existence. He alluded also to the manner in which the difficulties of setting up such a mercury column, arising from the want of proper contact between the mercury and the glass, may be overcome. The British and German tests agreed so closely as to show that the results might be used for commercial purposes, possibly for centuries; though, for scientific purposes, some change might be needed. He and others had been sent here by their Government with the object of coming to an agreement on this subject with Great Britain, and it was hoped that America and France would also adopt the resolutions.

Wire Standards of Electric Resistance, by Dr. Lindeck, of Berlin.—The author described experiments on this subject. Alloys containing manganese seem to be the best for the purpose. Those containing zinc are the most objectionable because of impurities. Changes of resistance depending on the process of winding the coils were also investigated. The best results were got with the alloy manganin. Changes of resistance, apparently due to oxidation from contact with the air, take place; but these can be avoided by varnishing the wire. The resistance rises slowly with temperature, reaches a maximum, and then decreases rapidly.

Prof. Sylvanus Thomson said that, in working with manganin, he had found that it could not be relied upon if too strong a current were sent through it. He agreed that no alloy containing zinc should be used.

On the Clark Cell, by Dr. Kahle, Berlin.—Dr. Kahle gave details of experiments made on Clark cells. He found that they furnished a very trustworthy standard of electromotive force, and that they were very suitable for practical work.

Prof. Carhart said that he had found cells, made by different persons at different times, gave practically the same result when used under the same conditions.

Mr. Glazebrook said that he had come to the conclusion that differences amongst the results given by different cells were due to the fact that the time taken to reach the equilibrium condition differed in different cells.

Preliminary Account of Oceanic Circulation, based on the Challenger Observations, by Dr. A. Buchan.—In communicating this account, Dr. Buchan remarked that the enquiry had so far advanced that the chief results could be stated. The *Challenger* observations have been supplemented by those of Mohn, Agassiz, J. T. Buchanan, Belknapp, and Capt. Wharton. The surface winds of the globe have a special bearing on the subject of ocean temperature. The surface winds of the Atlantic generate currents which have the effect of raising the temperature on the west side of the Atlantic, at depths from 100 to 500 fathoms, about 10 degrees above the temperature at these depths on the east side. At 500 fathoms the temperature is nearly the same at both sides of the Atlantic, but at lower depths the effects are reversed. At these depths the west side is more under the influence of the Arctic currents along the American coast, and the east side is more under the influence of the under currents from the Mediterranean and the equatorial regions of the Atlantic. This high temperature distribution extends northwards even beyond the Wyville Thomson ridge between Shetland and Iceland. At 700 fathoms the temperature just south of this ridge is five or six degrees higher than it is over the Pacific, Indian, and

South Atlantic Oceans at that depth. At 200 fathoms the temperature of the Mediterranean is about 56°, and is practically constant down to the bottom (1500 fathoms in some places). Similar conditions hold in the Gulf of Mexico, where the temperature at 700 fathoms is 25°·5, with no change at lower depths. On the other hand, north of the Wyville Thomson ridge in the North Atlantic, there is a uniform temperature of about 29°·5 at all depths below 700 fathoms—that temperature being about two or three degrees higher than the freezing point of the water. This undercurrent of warm salt water from the Mediterranean, extending even beyond the North Cape of Norway, seems to explain why there is no instance of an iceberg appearing off the west coast of Europe.

Physical Condition of the Waters of the English Channel, by Mr. H. V. Dickson.—The constitution of the samples of water agreed, on the whole, with that of the *Challenger* samples, coinciding entirely with that of the Atlantic water. The tidal currents are sufficiently strong to keep the water thoroughly mixed from the top to the bottom, except off Start Bay, where a vortex is formed—the water being colder in summer, and warmer in winter, than the surrounding water, and this spot is one of the best fishing grounds in the Channel.

On Primary and Secondary Cells in which the Electrolyte is a Gas, by Prof. Schuster.—When an electric discharge passes through a part of the gas filling a tube, all the gas is brought into a state in which it readily conducts electricity. Prof. Schuster has studied the laws of this conduction. If we assume that the primary phenomena of discharge depend on dissociation of the molecules, he remarked that it must often have appeared peculiar to experimenters that no phenomena of polarization appear. When an elementary gas is used no such phenomena appear. When compound gases are used only slight polarization appears; but Prof. Schuster has found that the phenomena become very marked when hydrocarbons are used. The law of decrease of polarization in this case resembles that which is observed when liquid electrolytes are used. This points to the performance of work of the nature of electrolysis. The magnitude of the effect depends on the nature of the electrodes. It is small when copper and iron are used; but is very large when aluminium or magnesium are used. When a latter metal was employed, a direct current being passed for a long time, a reverse electromotive force of 35 volts was got from a single cell. This shows that the action is similar to that of a secondary cell. Prof. Reinold has already described cases in which gases act as an electrolyte in a primary circuit when under the influence of a discharge. Prof. Schuster has found that, in such cases, the employment of aluminium electrodes gives very strong effects.

On Leaky Magnetic Circuits, by Dr. du Bois.—It appears from the experiments described that the leakage decreases when the magnetization is increased.

Experiments on the Electric Resistance of Metallic Powders, by Dr. Dawson Turner.—It is well known that metallic powders have very great electric resistance. This can be reduced to an extraordinary degree by the passage of an electric spark in their neighbourhood. Amongst other substances Dr. Turner has tried powdered aluminium, copper, annealed selenium, iron filings, small shot, mixtures of aluminium and resin fused into a solid mass, etc. The best results were obtained with the first two. A short glass tube, filled with powdered aluminium, is placed in circuit with one or two cells and a galvanometer. No current passes until a spark discharge occurs in the neighbourhood, when a fairly large effect becomes visible. The powder continues to conduct for a short time unless it be shaken or disturbed, when the effect ceases. In the case of the rod of aluminium and resin, mere shaking does not destroy the effect, though the application of heat does. When the resistance has once been lowered in this way, the powder becomes very sensitive, a spark at a great distance produces the effect, and a very slight jar destroys it.

On the Stability of Periodic Motions, by Lord Kelvin.—The mathematical investigation of this subject was illustrated by an experiment in which a simple harmonic vertical motion was given to the point of support of a pendulum. When the period of the superposed motion was one half of that of the natural motion of the pendulum, the equilibrium became unstable, and the slightest disturbance caused the vertical motion of the bob to be changed into transverse motion of increasing amplitude. If the superposed period were now lessened, the vertical motion again became stable. Similarly a rod poised vertically in unstable equilibrium could become stable by having its point of support moved with simple harmonic motion, of proper period, in a vertical line.

Prof. Osborne Reynolds remarked that it was well known to practical engineers that a revolving shaft, when driven at a certain speed, began to bend, and might even break, though at higher speeds it would again become straight. Lord Kelvin had now explained this effect.

On the Specific Conductivity of Thin Films, by Profs. Reinold and Rücker.—When the film was an aqueous soap solution containing a considerable portion of glycerine and a small proportion of a metallic salt, the specific conductivity was the same, whether the liquid was in mass or was drawn out into a film not exceeding 1-200,000 in. in thickness. When the liquid consisted of an aqueous soap solution alone, the specific conductivity increased when the thickness became small, until, in the thinnest film observed, it was seven times as great as at first. The effect seemed to be due to a breaking down of equilibrium when the tenuity was extreme.

A Contribution to the Theory of the perfect Influence Machines, by J. Gray, B.Sc.—The theory of the perfect influence machine has been shown by Clerk Maxwell to be analogous to Carnot's theory of the perfect heat-engine. Maxwell points out that there is a loss of energy in the ordinary influence machine through sparking at the contacts, which would render the machine inefficient, even though losses from leakage and the like were done away with. Maxwell has described a machine in which sparking and the loss due to it is eliminated. This is done by causing the carrier of electricity always to make contact with charging and discharging conductors when the former is at the same potential as the latter. In the case of the discharging conductor, this is done by prolonging the contact springs to meet the carrier; in the case of the charging conductors this is not sufficient; it is necessary to surround the ends of their contact springs by two additional conductors charged to an equal and opposite potential, and of such capacity as will just reduce to zero the potential of the small quantity of electricity left from the previous discharge. These additional conductors were called by Maxwell regenerators, as being analogous to regenerators in the heat-engine.

The object of the author is to investigate the efficiency of an influence machine constructed according to Maxwell's design, and other designs less perfect. This is done by drawing a QV (quantity-potential) energy diagram for one revolution of the carrier. The results obtained are as follows:—

			Theoretical efficiency.
Maxwell's machine			I
,,	,,	without regenerators	$\frac{Q}{Q+\frac{1}{2}av}$
,,	,,	without long contacts on receivers	$\frac{2}{3}$
,,	,,	without regenerators and without long contacts on chargers	$\frac{Q}{Q+\frac{1}{2}aV}$

where Q = quantity received or discharged by a carrier in each revolution,
V = the potential (numerical value) of the positive or negative receiver,
v = the potential of the residual charge to be reduced to zero by the regenerator,
a = the part of the carrier's capacity due to its not being completely surrounded by the discharging conductor.

The conclusion is that the regenerators are of much less importance than the long contacts in adding to the efficiency of an influence machine.

Experiments with a Ruhmkorff Coil, by Messrs. Magnus Maclean and A. Galt.—The quantity of electricity induced in a secondary circuit by a make in a primary circuit is equal to the quantity induced in the same secondary by a break in the primary. If, however, there is a non-metallic gap in the circuit, the *break* impulse causes a flow in one direction, and the *make* causes either no flow, or a much less flow in the opposite direction; because the short intense impulse of the former breaks down the resistance, while the comparatively long and less intense impulse of the make either does not break down the resistance at all or only does so to a slight extent, so that the effective resistance is much greater in one direction than in the other. To obtain the average difference of the quantity of electricity set in motion in one direction over that in the other, an electrolytic cell and a vacuum tube were placed in the secondary circuit of a small Ruhmkorff coil. The solution in the cell was sulphate of copper of density 1·7 with ½ per cent. of commercial sulphuric acid added. The mean of seven experiments, lasting from two to four hours, gave the average electrolytic current, calculated from the gain of the cathode, as ⅙ of a milliampere. A similar experiment, in which the vacuum tube was replaced by a very large liquid resistance, led to no result.

The Application of Interference Methods to Spectroscopic Measurement, by Prof. A. Michelson.—Prof. Michelson's "wave-compiler" consists essentially of a small plane sheet of glass with parallel surfaces and two mirrors. The mirrors are set at right angles to each other and the central plane of the glass passes through their line of intersection, making an angle of 45° with each of them. Rays of light from the source under examination fall upon the glass surface at an angle of 45°, and are partly reflected, partly transmitted, so as to suffer normal reflection at the mirrors, and finally proceed from the other surface of the glass, at an angle of 45°, to the eye. Normal displacement of one of the mirrors parallel to itself causes a difference of path which produces interference. If the source of light emits radiation of two wave-lengths (as in the case of incandescent sodium), or of more, the brightness of the interference bands—regarded from the centre outwards—exhibits periodic variation, which can be accurately observed. The law of variation can be calculated when the distribution of light in the source, as regards wave-length and intensity, is known. Conversely, the method can be used to determine the nature of this distribution. Mr. Michelson has examined various sources of light—oxygen, hydrogen, zinc, cadmium, mercury, &c.—and has found that lines which in the most powerful spectroscope appear single, are really double, triple, or even more complex. In examining hydrogen at different pressures and temperatures the results indicated that the widths of the component lines decreased as the pressure decreased, but not without limit. Investigations made on a large number of substances give strong confirmation of the kinetic theory of gases.

On a Periodic Effect which the Size of Bubbles has on their Speed of Ascent in Vertical Tubes containing Liquid, by Dr. F. T. Trouton.—The chief peculiarity observed when a bubble of air ascends in water is that the speed of ascent is a periodic function of the size of a bubble. The form of the curve obtained by plotting the volumes of the bubbles as abscissæ and the corresponding speeds as ordinates showed that at first, as would be expected, increase in size diminishes the speed; but afterwards the speed increases in value, then reaches a maximum at about twice the minimum speed; and so on two or three times, depending on the diameter of the tube employed. The oscillations in the curve die out in much the same fashion as those of a pendulum in a viscous medium. The form of the bubbles was almost spherical at the first minimum; after this the bubble is pointed at the top until the second minimum is reached, when it is again rounded at the top, but has a dumb-bell shape, and so on, presenting in this way similarities to the breaking up of a liquid column through surface tension. Liquids which do not mix with water were used instead of air; and air bubbles in other liquids were also used.

On a Method of Determining Thermal Conductivities, by Mr. C. H. Lees.—The method has more direct application to the determination of the conductivity of a liquid than previous methods have. It consists in measuring the amount of heat conducted, under given conditions, through a film of liquid placed between two copper cylinders. It was found most convenient to keep the upper cylinder at the temperature of the surrounding air, while the lower one was kept cool by water from the mains. Precautions were taken against errors from radiation, &c.

A Magnetic Curve Tracer, by Prof. Ewing.—The apparatus is designed to plot mechanically the ordinary magnetization curve. The curve is traced on a screen by a spot of light reflected from a mirror, which is subjected to two motions—one proportional to the magnetizing force, the other to the magnetization. These motions are communicated by means of the sagging of wires placed in air-gaps in magnetic circuits. In the one case, the wire carries a steady current in a varying field; in the other the wire carries the varying current in a steady field. The curves may be traced on sensitized paper; and the instrument should be of much use to engineers for testing purposes. In working with the instrument Prof. Ewing has observed true effects of magnetic time-lag in the inward penetration of magnetization.

On a Magnetic Balance, and its Practical Use, by Prof. du Bois.—A test bar of standard size is placed within a magnetizing coil. Over this is placed an iron yoke, balanced on a knife edge, and having attached to it a graduated scale with sliding weights. When a current passes through the coil the equilibrium is disturbed, and it is restored by sliding the weight along the scale. The position of the weight then gives the magnetization in absolute measures in c.g.s. units. The position of the yoke is one of unstable magnetic and mechanical equilibrium.

On Earth Current Storms in 1892, by Mr. W. H. Preece.—In communicating this paper, Mr. Preece spoke of the great importance of observers at all parts of the globe contriving to collect data regarding electric storms.

On the Dielectric of Condensers, by Mr. W. H. Preece.—The author pointed out that in the condensers used by him there was evidence of work done upon the insulating material, which necessarily retarded the rate of propagation of signals.

On Polarizing Gratings, by Prof. du Bois.—The author has constructed minute gratings with silver wire scarcely visible to the naked eye. Radiant heat and long light waves are polarized by these gratings in the same way as electromagnetic radiations are polarized by larger wire gratings.

The Volume Effects of Magnetism, by Dr. C. G. Knott.—The results for iron tubes have been already described in NATURE. In one case a steel tube, of given bore and thickness of wall, gave increase of internal volume in all fields used. Usually the volume diminishes in low fields and increases in high. The effects were shown to the audience by projection upon a screen.

An Estimate of the Rate of Propagation of Magnetization in Iron, by Prof. Fitzgerald.—Assuming that the iron is constituted of a system of little magnets, and with possible assumptions as to the size of these magnets and their strength, it is found that their natural rate of vibration may be one hundred millions per second. Unless the period of the vibration propagated through the iron approximates to this the wave lengths would be very small; while quicker vibrations, with periods like those of light, would not be propagated at all.

Experimental Proof that the Coefficient of Absorption is not affected by Density of Illumination, by Dr. W. Peddie.—When parallel rays of light pass through a uniform absorbing medium, the intensity of the light diminishes according to a certain law. The assumption which, on this point, is made the basis of the theory of radiation is that the fractional dimunition of intensity, at any stage, per unit of thickness traversed (called the coefficient of absorption), is independent of the intensity of the light. Sir G. Stokes has indicated a method of testing the point by the reflection of light, at nearly perpendicular incidence, from the surface of glass—part of the absorbing medium being placed in the path of half of the light before reflection, and a similar part being placed in the path of the other half after reflection. Both portions, being then projected on a screen, could be directly compared in respect of colour and intensity. No test seems to have been made by this or any other method. In Dr. Peddie's method light is passed through two double image prisms and a plate of quartz. Four rays are thus produced, coloured alike in pairs, the colour of one pair being complementary to that of the other. The colour of one pair can be made to match as nearly as possible the colour most readily absorbed by the medium, similar portions of which are placed at different distances from the points from which these rays are made to diverge by means of a lens. The light being projected on a screen, a direct comparison is obtained. The media used were pieces of surface-coloured glass. In no case was any difference observed, although the intensity varied from 1 to 1000, and the eye could have observed the difference of one per cent. in the brightness of the two discs thrown on the screen, without the additional help of change of colour.

On Dispersion in Double Refraction due to Electric Stress, by Dr. John Kerr.—The fact of dispersion has been established, and it is found that the optical effect depends upon the wave-length, being the inverse ratio of the square root of the wave-length.

On a Delicate Calorimeter, by Messrs. J. A. Harker and P. J. Hartog. This is essentially a Bunsen ice-calorimeter, with solid acetic acid instead of ice, so being much more delicate, and capable of being used at ordinary temperatures.

On Graphic Solutions of Dynamical Problems, by Lord Kelvin.—The method of drawing meridional curves of capillary surfaces of revolution, described in "Popular Lectures and Addresses," vol. i., 2nd edition, pp. 31–42, suggests a corresponding method for the solution of dynamical problems.

Reduction of every problem of Two Freedoms in Conservative Dynamics, to the drawing of Geodetic Lines on a Surface of given Specific Curvature, by Lord Kelvin.

1. Any conservative case of two-freedom motion is proved to be reducible to a corresponding case of the motion of a material point in a plane.

2. In plane conservative dynamics, with any given value for the energy-constant, E, the resultant velocity, q, at any point (x, y) is a known function of (x, y), being given by the equation

$$q^2 = 2(E - V) \quad . \quad . \quad . \quad . \quad \cdot (1)$$

where V denotes the potential at (x, y); and every problem depends on drawing lines for which $\int q ds$ (the Maupertius "action") is a minimum.

3. Considering any part, S, of the infinite plane, find a surface, S′, such that any infinitesimal triangle A′B′C′ drawn on it has its sides q/q_0 of those of a corresponding triangle ABC in the field, S, of our plane problem; q_0 denoting the value of q at any particular point (x_0, y_0) in the plane. By the principle of least action we see instantly that the lines on S′ corresponding to paths on S, are geodetic. Thus the *adynamic* case of motion of a particle on S′, is found as a perfect and complete representative of the motion on the plane surface S, under force with any arbitrarily given function V, for its potential, and any particular given value, E, for the total energy of the moving particle.

4. It is easily proved that the surface S′, to be found according to §3, exists; and that its specific curvature (Gauss's name for the product of its two principal curvatures) at any point; is equal to

$$\frac{q^2_0 \, \Delta^2 \log q.}{q^2}$$

5. Examples are given of the finding of S′. As one example, illustrating the practical usefulness of this method in dynamics, the problem of the parabolic motion of an unresisted projectile is reduced to the drawing of geodetic lines on a certain figure of revolution of which the explicit equation is expressed in terms of elliptic functions.

THE PERIODIC VARIATIONS OF ALPINE GLACIERS.

THIS twelfth Report, dealing with the Alpine glaciers and their changes, by Dr. Forel, comes in the nick of time, and will be generally welcomed, for it announces that the question of glacier-changes in the Alps will in future be studied systematically; and, further, we learn in a postscript that the State Council of the Canton of Le Valais have, on the proposition of M. Maurice de la Pierre, head of the Home Department, decided to take under its efficient direction the studies of observation and control of the variations of glaciers. These observations are confided to the charge of the Cantonal Administration of Forests, the head of which is M. Antoine de Torrenté at Sion. M. Forel records this act of intelligent and prudent administration with keen satisfaction and true gratitude, and would gladly see it imitated by other cantons possessing glaciers. M. Forel publishes also the report, which, in compliance with the wishes of M. de la Pierre, he had addressed to the Home Department of Le Valais. It is equally applicable to the glaciers of other cantons in Switzerland, and we therefore print it *in extenso*.

M. de la Pierre, Councillor of State, head of the Home Department, Sion.

SIR,—Referring to the interview you granted me on January 31, and in reply to your question, I have the honour to give you the following particulars:—

Glaciers in general, and particularly those of Le Valais, are subject to variations in shape, which, according to an irregular periodicity, cause them sometimes to grow in length, in breadth, in thickness, sometimes to decrease, often in very considerable proportions. These variations, which in recent centuries have attracted the attention of the populations interested and of naturalists, have in this century been the subject of direct study, especially during the last twenty years.

It has been recognized that most of the great catastrophes which have ravaged the region of the high Alps, have been caused by these glacial variations. It is when the glacier extends, lengthens, arrives at its maximum, that it not only invades the fields and destroys Alpine chalets, but barricades the valleys, arrests the flow of rivers, and creates temporary lakes, the evacuation of which ravages the country; or else, surpassing its usual dimensions, it forms an avalanche, the destructive power of which is terrible. Taking my examples from Le Valais, I attribute to forces of this kind: the catastrophes of the Valley of Saas, 1633, 1680, 1772, caused by the overflow of the lake Mattmarck, due to the stoppage of the Viège by the glacier of Allalin; the catastrophes of the valley of Bagne, 1545, 1605, 1818, caused by the formation of a temporary lake behind the barricades of the glacier of Giétroz; the catastrophes of Randa, 1636, 1819, caused by the fall of the glacier of Bies, which had assumed extraordinary dimensions; perhaps we might also attribute to the same source the inundations of St. Bartholomew, 1560, 1635, 1636, 1835, which may have been due to the excessive increase and fall of the terminal extremity of the glacier of Plan-névé of La Dent-du-Midi.

Since these variations of glaciers are the cause of great catastrophes in mountainous regions, they are deserving of attentive study; there is scope to form theories and to recognize the rhythm of their periodicity; it is very necessary to be able to foresee their development, in order to ward off threatening events.

Now, the preparatory study which we have made within the last few years has shown us that the periodicity of glacial variations is much longer than was formerly believed to be the case; the popular dictum that the increase in the size of glaciers recurs every seven years is certainly incorrect. We cannot yet give definite figures, but probably the cycle of glacial variation is as much as 35 to 50 years. The latter period alone has been studied attentively; if 1850 or 1855 be fixed upon as the epoch of maximum of glaciers, they have been steadily decreasing in past years, so that from 1870 to 1875 we were not aware of a single one on the increase. In 1875 the Glacier des Bossons du Mont Blanc gave the signal for a new period by commencing to lengthen out; it was followed in 1878 and 1879 by the glaciers of Trient and Zigiorenove, then successively by some thirty glaciers in different valleys of Le Valais; but the phase of increase is not yet general in your canton; a number of large glaciers, Arolla, Otemma, Corbassière, Le Gorner, Le Rhone, are still decreasing or stationary. It is only of the Mont Blanc group that the increase can be said to be general; in Le Valais it is in process of development, and we are still very far from the maximum stage of glaciers. If, as is probable, the maximum only arrives at the commencement of next century, the actual period of glaciers will have lasted more than fifty years.

Thus this is a phenomenon, whose cycle is equal or superior to that of the average human life; one generation of men witnesses only one of the glacial variations. It is a phenomenon of such majestic slowness that its study is exceptionally difficult.

A phenomenon of which a man can, in his whole life, see but one manifestation, surpasses in its amplitude the powers of initiative individual study. To observe the facts of so prolonged a period, organizations are required of a superior duration. Shall we address ourselves, therefore, to learned societies, which, being continually renewed, may be supposed to have sufficient continuance? We fear that, even in the most powerful of these societies, Societies of Naturalists and the Alpine Clubs, a sufficiently keen interest in observations, which can only be utilized after the lapse of some generations will not be felt for the observations to be organized and carried out with the necessary perseverance. It seems to us that the State alone, by virtue of the indefinite continuance it enjoys, is in a position to follow out this study with a sufficiently long grasp. However much we may be in favour of private individual or collective initiative action in researches and scientific work, in this special case we believe it advisable to have recourse to the State administration, considering it the only institution of sufficient duration to proceed to the study of phenomena of such extreme slowness.

We therefore take the liberty of addressing ourselves very respectfully to the Government of the Canton of Le Valais, and begging it to introduce the study and observation of the variations of glaciers, which have so great an influence on the prosperity of mountain populations.

It seems to us that the State department best fitted for such a